Claims

1. A proximity sensor mountable adjacent to an aperture of a metallic motor vehicle for determining the presence of an object in the path of or proximate to a closure panel that moves between a fully open position and a closed position, the sensor comprising:

first and second electrodes encased in a non-conductive casing mountable on the vehicle, the two electrodes defining a capacitance CE1/2 therebetween;

a reference capacitor (C1);

a first switch for selectively connecting the first electrode to the reference capacitor or to chassis ground;

a second switch for selectively connecting the second electrode to a first voltage reference source (V_{ref1}) or to chasis ground;

a controller for controlling the first and second switches in order to periodically charge the capacitance CE1/2 and transfer the charge stored thereon to the reference capacitor.

2. A proximity sensor according to claim 1, wherein the controller transfers charge from the capacitance CE1/2 to the reference capacitor for a fixed number of periods for each charge and discharge cycle of the reference capacitor.

3. A proximity sensor according to claim 2, wherein the controller measures the voltage level of the reference capacitor.

4. A proximity sensor according to claim 1, wherein the controller transfers charge from the capacitance CE1/2 to the reference capacitor for a variable number of periods for each charge and discharge cycle of the reference capacitor.

5. A proximity sensor according to claim 4, wherein the controller records the number of periods, N, required to transfer charge from capacitance CE1/2 to the reference capacitor until it reaches a voltage equal to a second voltage reference (V_{ref2}).

6. A proximity sensor according to claim 2 or claim 4, wherein the controller calculates the value of capacitance CE1/2 according to the following formula: CE1/2 = $(C1^* V_{ref2})/(N^*V_{ref1})$.

7. A proximity sensor according to claim 1, 2 or 4, wherein the reference capacitor (C1) forms part of a charge integrator circuit connectable to the first switch.

8. A proximity sensor according to claim 7, wherein the integrator circuit includes a switch controllable by said controller in order to dissipate charge from the reference capacitor (C1).

9. A proximity sensor according to claim 8, including a signal amplifier connected between the charge integrator circuit and the controller.

10. A proximity sensor mountable adjacent to an aperture of a metallic motor vehicle for determining the presence of an object in the path of or proximate to a closure panel that moves between a fully open position and a closed position, the sensor comprising:

first and second electrodes encased in a non-conductive casing mountable on the vehicle, the two electrodes defining a capacitance CE1/2 therebetween, a capacitance CE1 between the first electrode and chassis ground, and a capacitance CE2 between the second electrode and chassis ground;

a reference capacitor (C1);

a first switch for selectively connecting the first electrode to the reference capacitor or to chassis ground;

a second switch for selectively connecting the second electrode to a first voltage reference source (V_{ref1}) or to chasis ground;

circuitry for controlling the first and second switches in order to periodically charge the capacitance CE1/2 and transfer the charge stored thereon to the reference capacitor without transferring substantially any charge stored on the capacitances CE1 and CE2 to the reference capacitor.

11. An anti-pinch assembly for a closure device of a motor vehicle, said assembly comprising:

a closure panel, supported by the motor vehicle, and moveable between a fully open position and a closed position;

a controller operatively connected to the closure panel for controlling the operation thereof, said controller including a proximity sensor mountable adjacent to an aperture of the vehicle for determining the presence of an object in the path of the closure panel, the sensor comprising

first and second electrodes encased in a non-conductive casing mountable on the vehicle, the two electrodes defining a capacitance CE1/2 therebetween; a reference capacitor (C1),

a first switch for selectively connecting the first electrode to the reference capacitor or to chassis ground,

a second switch for selectively connecting the second electrode to a first voltage reference source (V_{ref1}) or to chasis ground, and

circuitry for controlling the first and second switches in order to periodically charge the capacitance CE1/2 and transfer the charge stored thereon to the reference capacitor;

said sensor providing an obstruction signal to the controller for preventing the movement of the closure panel when an object is sensed in the closure path.

12. A method of sensing the presence of an object in the path of or proximate to a closure panel, mounted in a metallic structure, that moves in an aperture between a fully open position and a closed position, the method including:

mounting first and second electrodes encased in a non-conductive casing on the structure near the closing edge of the aperture, whereby the two electrodes define a capacitance CE1/2 therebetween, a parasitic capacitance CE1 between the first electrode and chassis ground, and a parasitic capacitance CE2 between the second electrode and chassis ground;

provisioning a reference capacitor (C1);

cyclically connecting (a) the second electrode to a voltage reference source (V_{ref1}) and the first electrode to chassis ground and (b) the second electrode to chassis ground and the first electrode to the reference capacitor, thereby periodically charging the capacitance CE1/2 and transferring the charge stored thereon to the reference capacitor whilst short-circuiting the parasitic capacitances; and

comparing the charge on the reference capacitor, the time period required to charge the reference capacitor to a specified voltage, or a calculated value for CE1/2 against a reference value in order to derive an obstruction signal.

13. A sensing method according to claim 12, wherein the value of capacitance CE1/2 is calculated according to the following formula: $CE1/2 = (C1 * V_{C1})/(N * V_{ref1})$, where V_{C1} is the voltage on the reference capacitor.

14. A sensing method according to claim 12, wherein the reference capacitor (C1) forms part of a charge integrator circuit connectable to the first electrode.

15. A proximity sensor according to claim 14, wherein the integrator circuit includes a switch in order to periodically dissipate charge from the reference capacitor (C1).